2 – STAGE SCREENING OF MIXED JUICE TO IMPROVE JUICE CLARIFICATION – A NEED OF THE TIME

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ABSTRACT

In its true sense good "juice clarification" as rightly said begins from the stage of separation of fine bagasse from the unscreened juice at milling station itself, much before the mixed juice enters into the clarification house. Due to growing trend of much higher quantities of bagasse of more fine nature entering into mixed juice studies were undertaken at many sugar factories in order to find out techno-commercially viable solution for reducing the bagasse entering into clarification house.

This paper presents the earlier efforts in this direction together with one of the best options arrived at by using proven technology of 'rotary' juice screening.

Keywords: Unscreened and screened mixed juice, Rotary Juice Screen, fiber, cost economics.

Analytical method used: ICUMSA GS7-13 (1994) – Accepted, for finding out fiber content in the juice.

INTRODUCTION

While addressing to the core issue of higher quantities of fine bagasse fibers entering into process house as reported by good number of factories more particularly over a period of last three seasons it was decided to conduct a series of tests and trials with the active participation and cooperation of those factories where the situation was found to be of seriously alarming nature.

Examples in sugar industry for stage wise operation could be cited as; three stages of A, B and C massecuite pan boiling are required to crystallize out maximum sugar from syrup / mother liquor. Similarly in order to extract maximum sugar from sugar cane the milling tandem comprises of 4 to 5 mills

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as “stages”. Likewise due to ‘increasing tendency of fine powder-like formation of cane fiber’ it has now become necessary to separate these fiber particles in two stages, initially “coarse separation” followed by “fine separation”.

Present situation

Thanks to our mill engineer colleagues appreciating their best consistent efforts to maximize the P.I. of prepared caneobviously for the good reason and with the good intention of improving mill extraction and is also ‘A need of the Time’ indeed.

It is being observed that well prepared cane with the long thread-like formation of cane fiber at cane preparatory device for rupturing of cane cells is already a story of the past and that more and more powder/dust formation of cane fiber is unintentionally found to be occurring in almost all factories. It is later observed that higher quantities of these finely pounded fiber particles are found to be escaping through universally opted size of 0.5 mm wedge bar gap of rotary juice screen drum. This resulted into creating serious processing problems at clarifications house as well as causing mechanical problems like choking at pumps, juice heater headers and at wide gap PHE. The problem was found further aggravated so such so that these fine light weight fiber particles started appearing in clear juice which was very rarely used to be observed in earlier days. At times the sugar crystals were also found containing these fiber particles acting as nuclei for crystal formation, seriously deteriorating the quality of sugar.

Data collection and Interpretation

Over a pretty long period of time since 1997 till this date more than a thousand analyses at various Rotary Juice Screen installations were carried out and data was compiled with respect to fiber content of unscreened mixed juice and the residual fiber content in the screened mixed juice. Universally followed ICUMSA method of GS7-13 (1994) – Accepted, was used for fiber content analysis. The data collection was done at the Rotary Juice Screen installations at various factories having same wedge bar opening of 0.5 mm and during the very first season of commissioning.

Since the Rotary Juice Screen was new there was no question of any likely rounding off of sharp edge of wedge bar and also no reason for the wedge bar gap getting widened which occurs only after a long service period of Rotary Juice Screen caused due to normal wear and tear.

The data was broadly divided in to three “5-YEAR” time zones and is tabulated below:

TABLE 1

Sr. No.	"5-year" time zone	% fiber content in the screened mixed juice
1	2000-2005	0.135 to 0.150
2	2005-2010	0.150 to 0.165
3	2010-2015	0.180 to 0.230

The above findings are irrespective and independent of fiber content in the unscreened mixed juice which varied 0.8% - 1.2%. This clearly indicates the increasing trend and growing tendency of fine powder/dust formation at cane preparatory device.

Preventive remedial measures prior to juice clarification

It was then felt necessary by sugar industry that rather than going into inadequate corrective actions alone it would be much desirable to provide 'prior' fool proof preventive measures for the effective separation of these fine fibers at milling station itself and never allow them to enter into clarification house. At the same time the system should be "cost effective" allowing immediate returns and forever recurring financial gains.

After closely observing this growing trend of increased residual bagasse content in screened mixed juice investigative efforts were taken up on various likely measures in order to reduce fiber content of screened mixed juice as much as practically feasible by using Rotary Juice Screen in 'single' stage operation.

Various efforts carried out in this direction are mentioned below:

1. Reversing the direction of screen rotation
2. Rotational speed variation
3. Running the screen drum "Dirty"
4. Differential wedge bar opening
5. Slope of screen drum
6. Rotary Juice Screen with smallest ever wedge bar opening of 0.25 mm

Description and operation of 2-stage rotary juice screening system

For the two stage operation of Rotary Juice Screen the 1st stage screened mixed juice should be delivered to 2nd stage Rotary Juice Screen as far as possible by gravity flow according to mill house layout and head room availability.

1st Stage Rotary Juice Screen

This is the one which already exists at a standard milling tandem.

The unscreened mixed juice from mills is collected into existing unscreened mixed juice receiving tank and pumped to the first stage rotary juice screen fitted with 0.5 mm wedge bar opening. The bagasse separated from 1st stage rotary juice screen is discharged into the rake carrier and screened mixed juice from 1ststage rotary juice screen is delivered to 2nd stage rotary juice screen.

2nd Stage Rotary Juice Screen

This Rotary Juice Screen is provided withdrum having wedge bar opening of 0.35 mm.

Screened mixed juice from 2nd stage rotary juice screen is discharged into existing screened mixed juice receiving tank and pumped for onward juice clarification process. The additional bagasse separated at 2nd stage screen is also discharged into the rake carrier.

TABLE 2 – DATA COLLECTED AT 2-STAGE ROTARY JUICE SCREEN - INSTALLED AT 5000 TCD PLANT

Sr. No.	A	B	C	D
	Bagasse in unscreened mixed juice before 1st stage Rotary Juice Screen % on oven dry basis	**Bagasse in screened mixed juice after 1st stage Rotary Juice Screen (0.5 mm opening) % on oven dry basis**	**Bagasse in screened mixed juice after 2nd stage Rotary Juice Screen (0.35 mm opening) % on oven dry basis**	**File bagasse fiber in clear juice resulting from clarifier % on oven dry basis**
1	0.78	0.184	0.071	0.001
2	0.82	0.174	0.069	0.0006
3	0.827	0.172	0.066	0.0008
4	--	0.176	0.062	0.0004
5	--	0.178	0.076	0.0009
6	--	--	0.074	0.0007
Average	**0.809**	**0.177**	**0.069**	**0.0008**

Bagasse separated at 1st stage = A-B = 0.809%-0.177%

Rotary juice screen = 0.632% mixed juice

Bagasse separated at 2nd stage = B-C = 0.177-0.069%

Rotary juice screen = **0.108%** mixed juice

TABLE 3 – COST ECONOMICS OF 2ND STAGE ROTARY JUICE SCREEN

Revenue gained by collecting additional bagasse @ 0.108 % mixed juice on oven dry basis at 2nd stage rotary juice screen based on data collected at a 5000 TCD plant – presented at Table 1		
Base		
1.	Total Annual cane crushing	7.5 lac tons
2.	Plant crushing capacity	5000 Tons/day
3.	Number of crop days	150
4.	Specific steam consumption of power house turbine	5.5 Ton per mW
5.	Steam generation per ton of bagasse	2.5 Ton
6.	Electric power tariff	Rs. 5,700/- per mWh.
Calculations		
1.	Residual bagasse content in screened mixed juice at 1st stage Rotary Juice Screen having 0.5 mm opening.	0.177% mixed juice on oven dry basis
2.	Residual bagasse content in screened mixed juice at 2nd stage Rotary juice Screen having 0.35 mm opening.	0.069% mixed juice on oven dry basis
3.	The reduction in residual bagasse content in mixed juice	0.108% mixed juice on oven dry basis
4.	For the sake of simplicity of calculations let us consider mixed juice % cane as,	100
5.	Hence the reduction of bagasse content % cane	0.108% cane on oven dry basis
6.	Let us consider moisture % mill bagasse as	50%
7.	Additional mill bagasse % cane	0.216% cane
8.	Quantity of additional mill bagasse per day	= 0.216 x 5000/100 = 10.8 Ton per day.
9.	Quantity of more steam generated by additional bagasse per day	= 10.8 x 2.5 = 27 Ton/day.
10.	Additional electricity generated	= 27/5.5 = 4.91 mWh/day.
11.	Revenue gained by generating more electrical power	= 4.91 x 5700 = Rs. 27,987/- per day. = Rs. 41,98,050/- per season of 150 crop days
	Forever recurring gain every season	**Rs. 42.00 Lacs**

Note for Table 3:

1) Now a days cogeneration power plant turbines are having higher efficiency requiring only 4.5 tons (or even less) of steam per mW electrical power

generation. This will result into more electricity generation per ton of steam allowing additional revenue by exporting more power.

2) The "overheads" for generating more electrical power at the existing cogeneration power plant by using additional bagasse just by 0.216% cane will get evenly distributed and hence electric power production cost will eventually get absorbed.

Other advantages

1) In addition to cost effective benefits there are other multifold advantages due to reduction in bagasse entering into clarification house like reduction in new colour forming compounds, reduction of floating particles in clear juice. As well as other mechanical advantages like preventing chocking at pumps, juice heater headers, tubes and PHE etc.

2) With decanter installation this situation is much favorable because considerable reduction of insoluble solids fiber content in the muddy juice will effectively reduce solid loading on decanter.

CONCLUSION

Having practiced all available permutations and combinations of Rotary Juice Screen design and its operation at actual factory conditions in 'single' stage format and after successfully installing 2nd stage Rotary Juice Screen having 0.35 mm wedge bar opening it can be stated that the desirable combination shall be to provide 0.5 mm wedge bar opening at 1st stage Rotary Juice Screen for "coarse" separation followed by the 2nd stage Rotary Juice Screen fitted with wedge bar screen having 0.35 mm wedge bar opening for "fine" separation.

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REFERENCE

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FIGURE 1

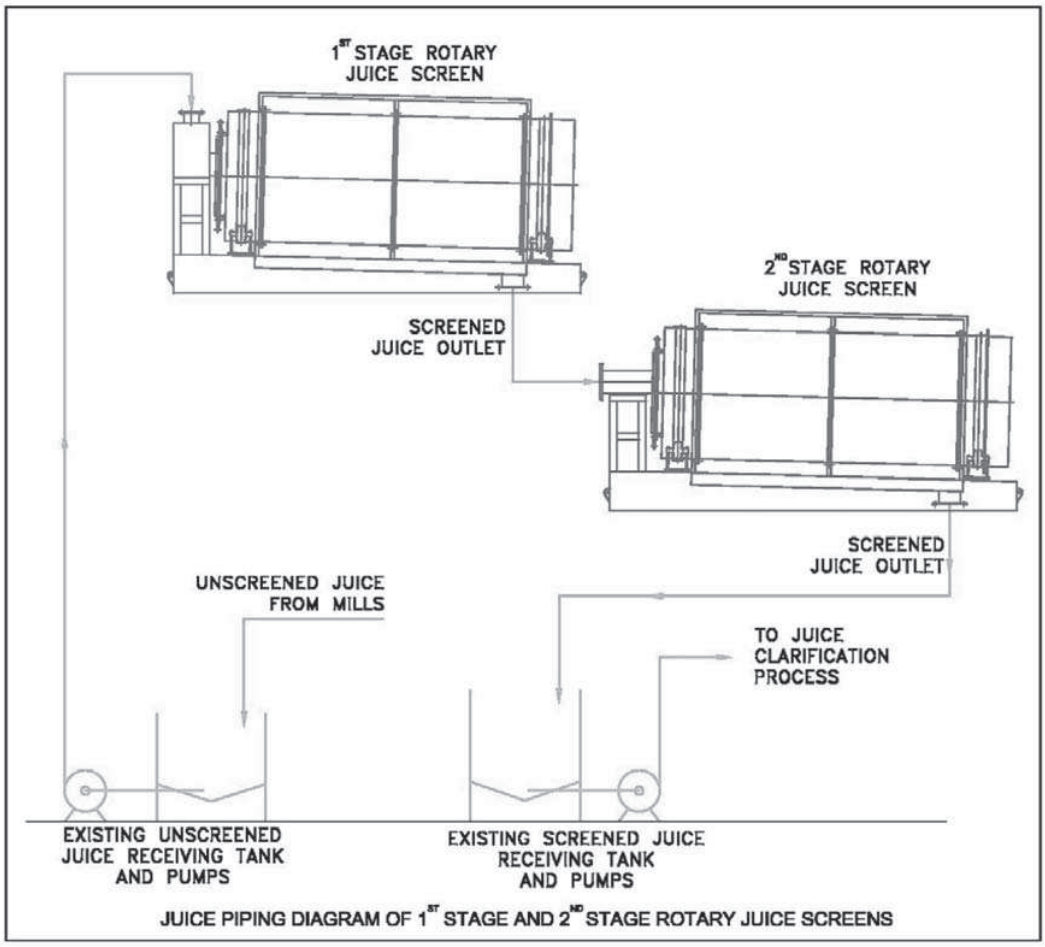
1ST STAGE ROTARY JUICE SCREEN
2ND STAGE ROTARY JUICE SCREEN
SCREENED JUICE OUTLET
SCREENED JUICE OUTLET
UNSCREENED JUICE FROM MILLS
TO JUICE CLARIFICATION PROCESS
EXISTING UNSCREENED JUICE RECEIVING TANK AND PUMPS
EXISTING SCREENED JUICE RECEIVING TANK AND PUMPS
JUICE PIPING DIAGRAM OF 1ST STAGE AND 2ND STAGE ROTARY JUICE SCREENS

FIGURE 2 – 2-STAGE ROTARY JUICE SCREENING SYSTEM AT 5000 T.C.D. SUGAR FACTORY